Preliminary Evaluation of Water Quality in the Vicinity of San Juan Generating Station and Recommended Corrective Actions

An investigation into potential sources of ground water and surface water observed at several monitoring points has been ongoing at the San Juan Generating Station since 2003. Preliminary results of the investigation for four monitoring wells (Qal-1, Qal-2, Qal-3 and MW-4) and two surface water monitoring stations (S-4 and S-5) are presented in this report. Locations of the sampling points are shown on FIGURE 1 and FIGURE 2.

It is recognized that a potential source must exist at a higher elevation than the sampling point to be a valid source. Additionally, a reasonable flow path from the potential source to the sampling point must exist. Collectively, these two characteristics are termed geometry. Sampling point elevations are presented in TABLE 1. Major ions trilinear diagrams were used to evaluate potential sources for the water observed in monitoring wells Qal-1, Qal-2, Qal-3 and MW-4. These diagrams are attached in Appendix A. The chloride and nitrate concentrations for the most recent samples from the potential sources and sampling points are presented in TABLE 2. The resulting indicated sources and estimated contributions are presented in TABLE 3.

The Qnt aquifer is a linear saturated unconsolidated deposit, which generally follows the historic flow path of the Westwater Arroyo and then the flow path of the Shumway Arroyo downstream from the natural confluence (FIGURE 2). The aquifer is about 1000 feet wide and 20 feet thick in the vicinity of the San Juan Generating Station.

Based on the geometry of the saturated unconsolidated deposits (i.e., Qnt and Qal), well QNT and surface water sampling sites S-4 and S-5 are along a groundwater flow path in the Qnt aquifer from upstream to downstream. Wells Qal-3, 2 and 1 are completed in groundwater tributaries to the Qnt aquifer, which enter from the west (the area where the San Juan Generating Station is located).

Recent water quality data for the monitoring wells and surface water sampling sites discussed above have been plotted on FIGURE 3. A preliminary analysis of FIGURE 3 suggests that the waters at S-4 and S-5 are mixtures of the upstream Qnt aquifer water represented by the QNT sample and groundwater flow coming from the Generating Station area represented by the Qal-1, 2 and 3 samples, because the S-4 and S-5 samples plot between QNT and Qal-1, 2 and 3.

The variations in TDS along the groundwater flow path can be explained by concentration of salts by evapotranspiration and dilution by the tributary flows along the flow path.

In summary, the data presented provides us with reasonable confidence that the water sampled at S-4 and S-5 contains a component of groundwater coming from the Generating Station area.

The recommended corrective actions to address underground leakage at the San Juan Generating Station consist of the corrective actions listed in TABLE 4 including construction of a groundwater recovery trench at Location E which is about 4000 ft. down stream from the San Juan Generating Station along the groundwater flow path of the Qnt aquifer (FIGURE 2). The objective of the groundwater recovery trench would be to capture virtually all of the flow in the Qnt aquifer, including contributions from the San Juan Generating Station, and return the water to the process water system at the station for reuse. Location E was selected because it is downstream from the maximum distance that contaminants from San Juan Generating Station might have traveled in the Qnt aquifer based on a particle velocity of 90 ft/year and a travel time of 33 years. Additionally, it is in an undeveloped area and the Qnt aquifer is only about 250 ft. wide at that location. Also, it would not be necessary to disturb the arroyo channel to construct the recovery trench at Location E. Details of the proposed groundwater recovery trench construction are presented in FIGURE 4, 5 and 6. Preliminary estimates indicate that the total flow in the Qnt aquifer at Location E is about 16 ac.ft/yr.

LIST OF FIGURES

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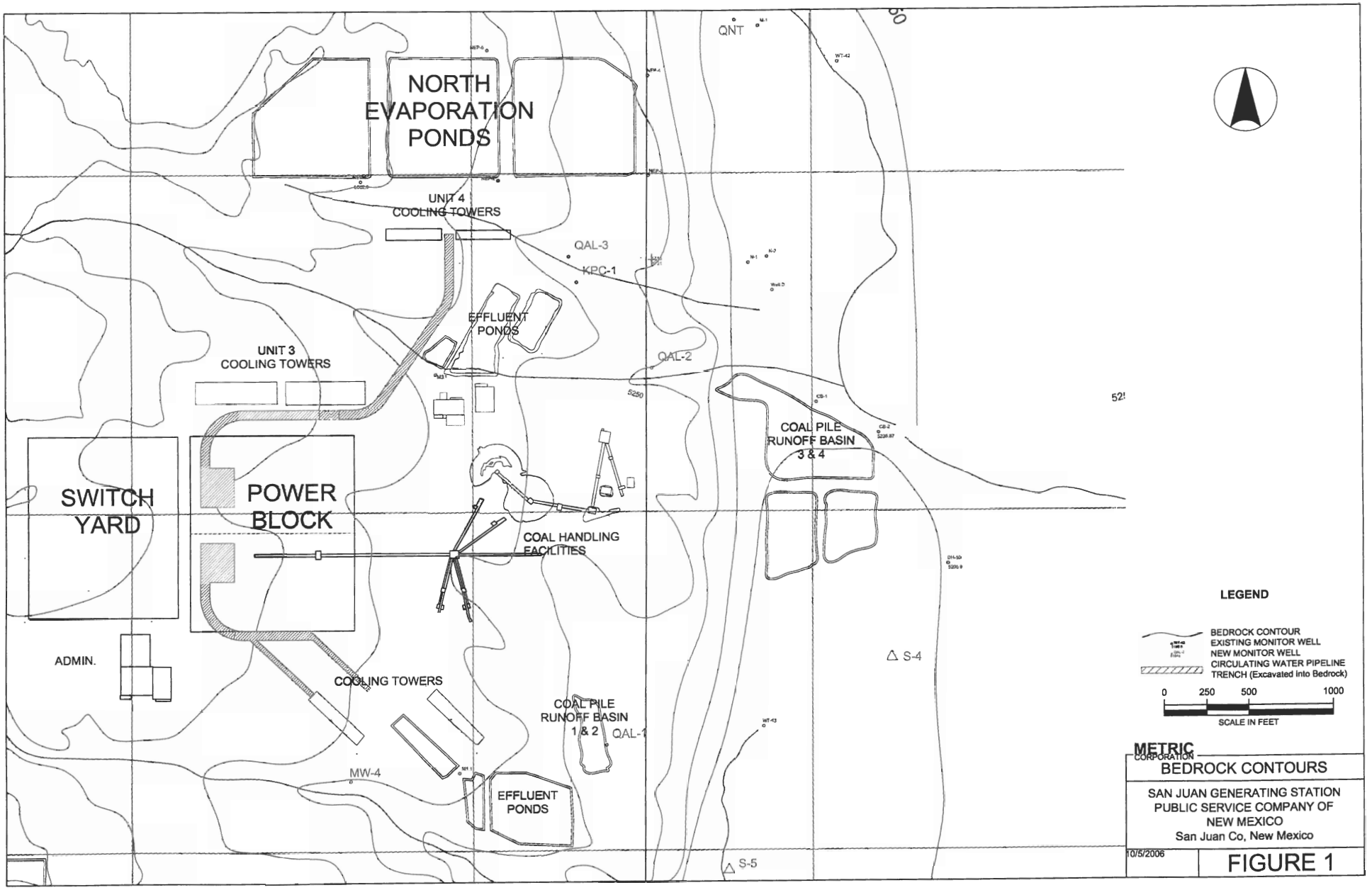
LIST OF APPENDICES


NORTH EVAPORATION PONDS
UNIT 4 COOLING TOWERS
QAL-3
KPC-1
EFFLUENT PONDS
UNIT 3 COOLING TOWERS
QAL-2
5250
SWITCH YARD
POWER BLOCK
COAL HANDLING FACILITIES
COAL PILE RUNOFF BASIN 3 & 4
ADMIN.
COOLING TOWERS
COAL PILE RUNOFF BASIN 1 & 2
QAL-1
MW-4
EFFLUENT PONDS
QNT
WT-42
S-4
S-5
LEGEND
BEDROCK CONTOUR
EXISTING MONITOR WELL
NEW MONITOR WELL
CIRCULATING WATER PIPELINE TRENCH (Excavated into Bedrock)
0 250 500 1000
SCALE IN FEET
METRIC CORPORATION
BEDROCK CONTOURS
SAN JUAN GENERATING STATION
PUBLIC SERVICE COMPANY OF NEW MEXICO
San Juan Co, New Mexico
10/5/2006
FIGURE 1

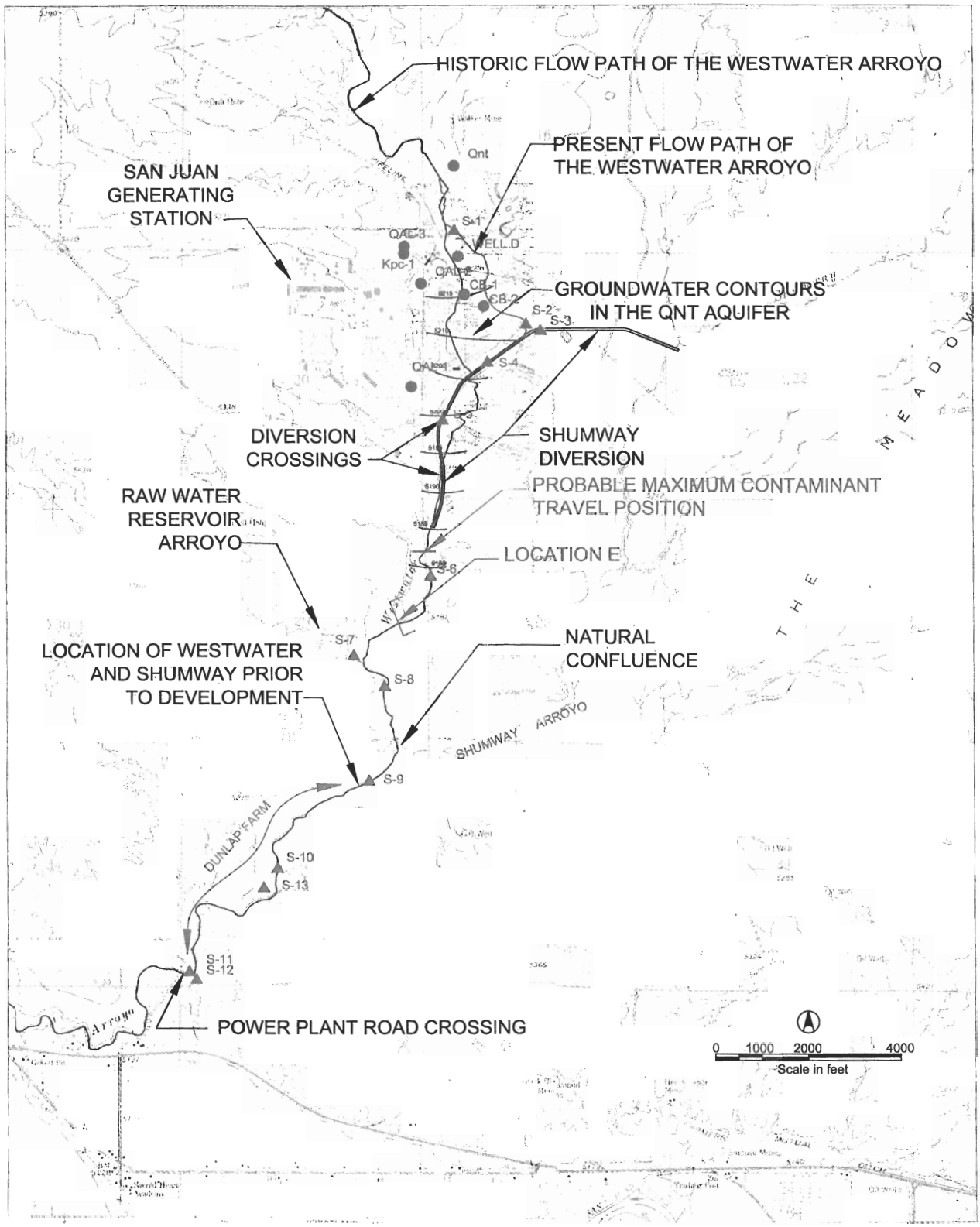


FIGURE 2
PROPOSED RECOVERY TRENCH
LOCATION MAP

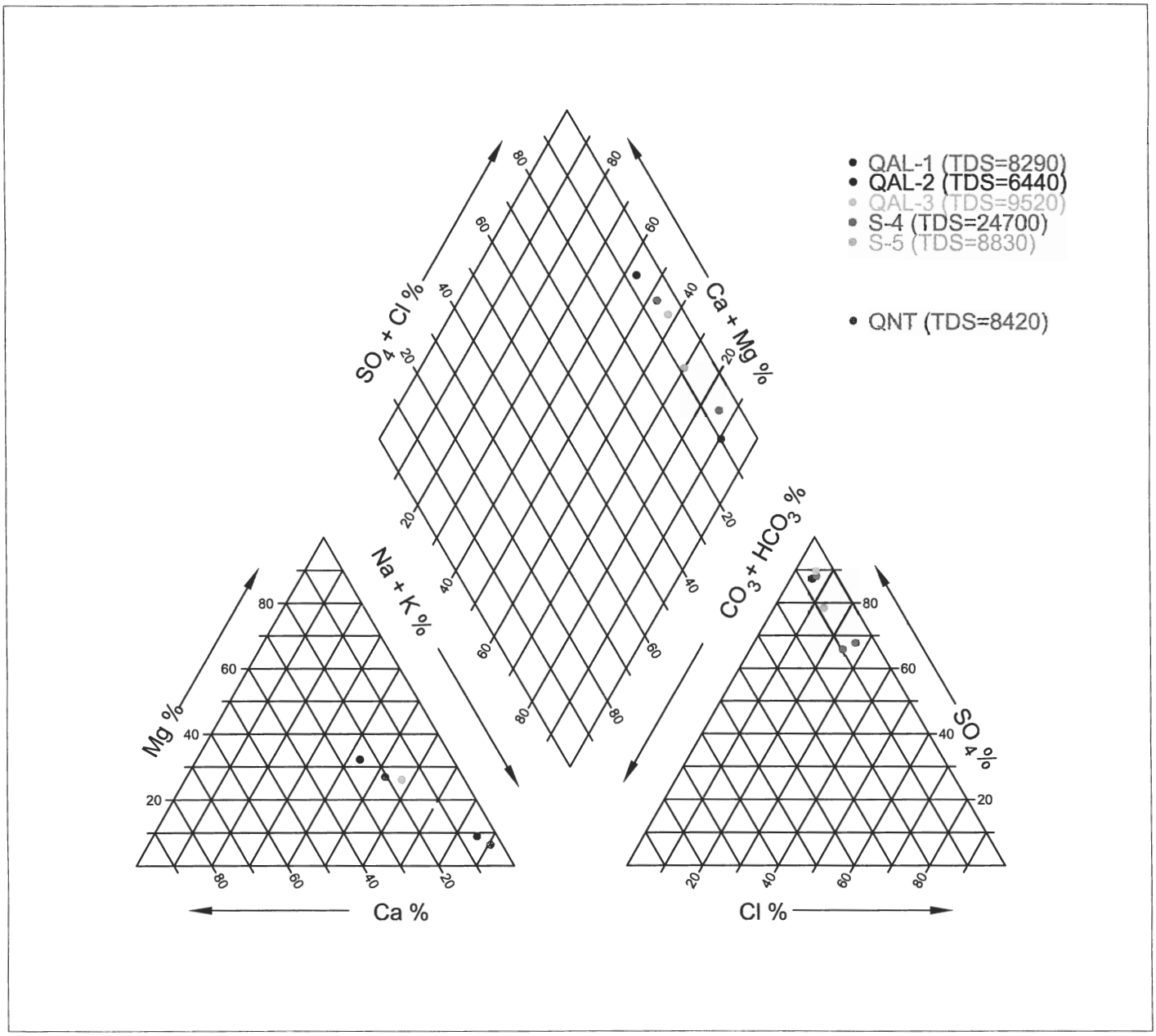
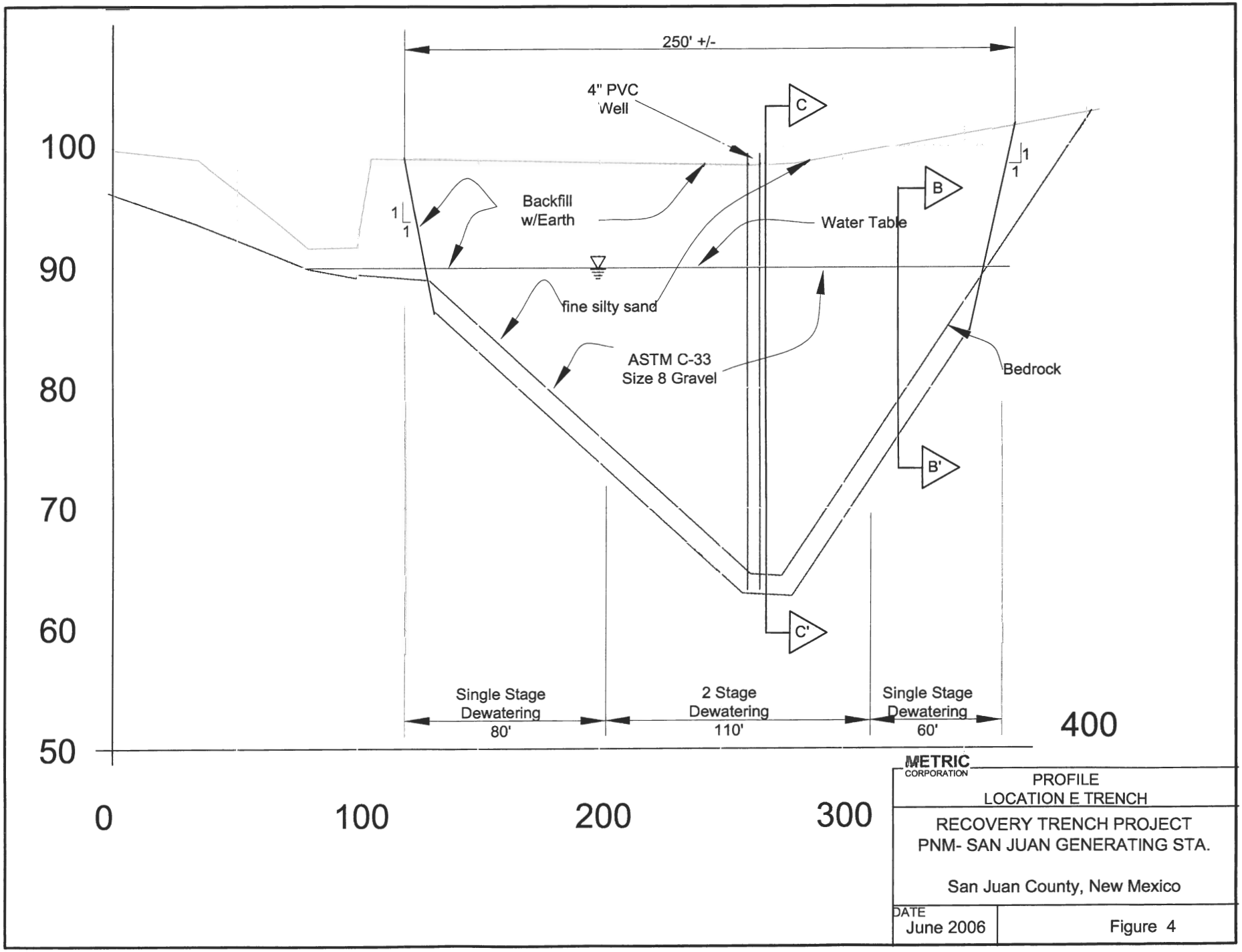


FIGURE 3
TRILINEAR DIAGRAM



METRIC CORPORATION

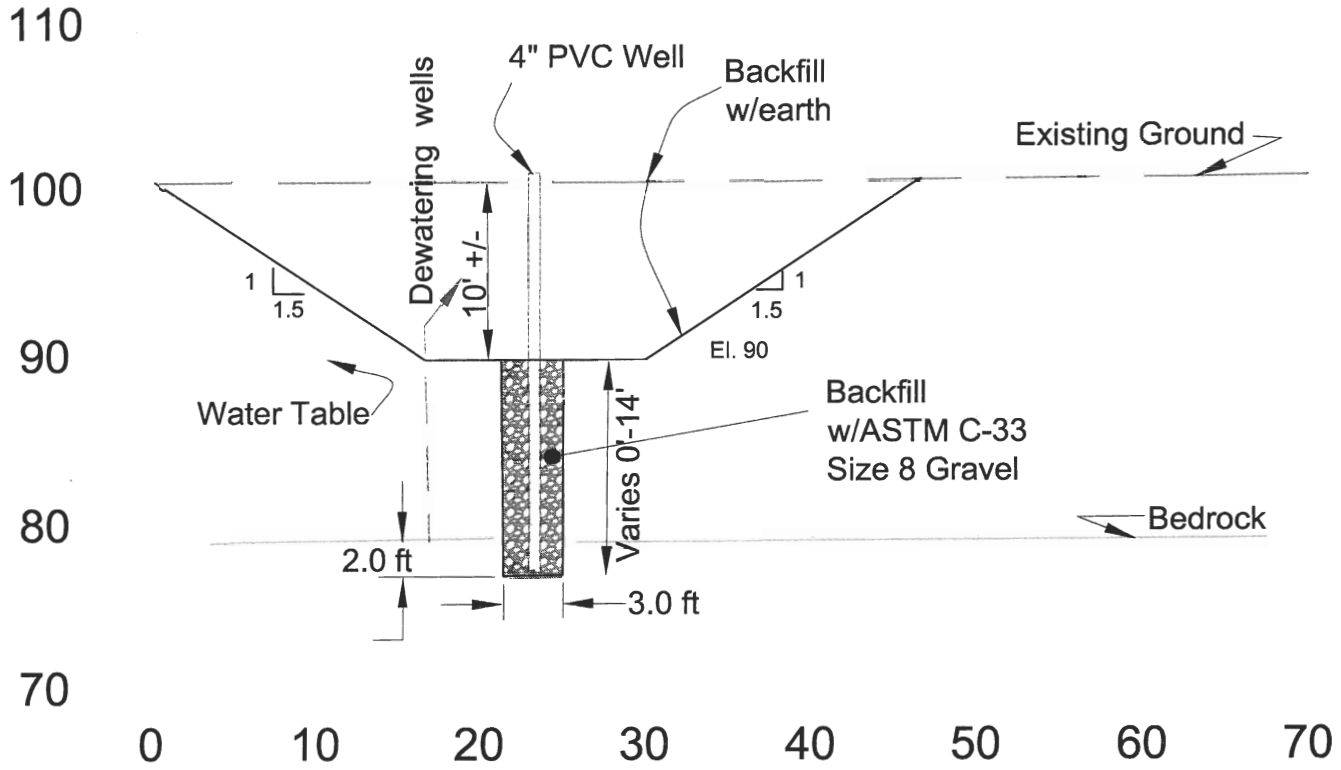
PROFILE
LOCATION E TRENCH

RECOVERY TRENCH PROJECT
PNM- SAN JUAN GENERATING STA.

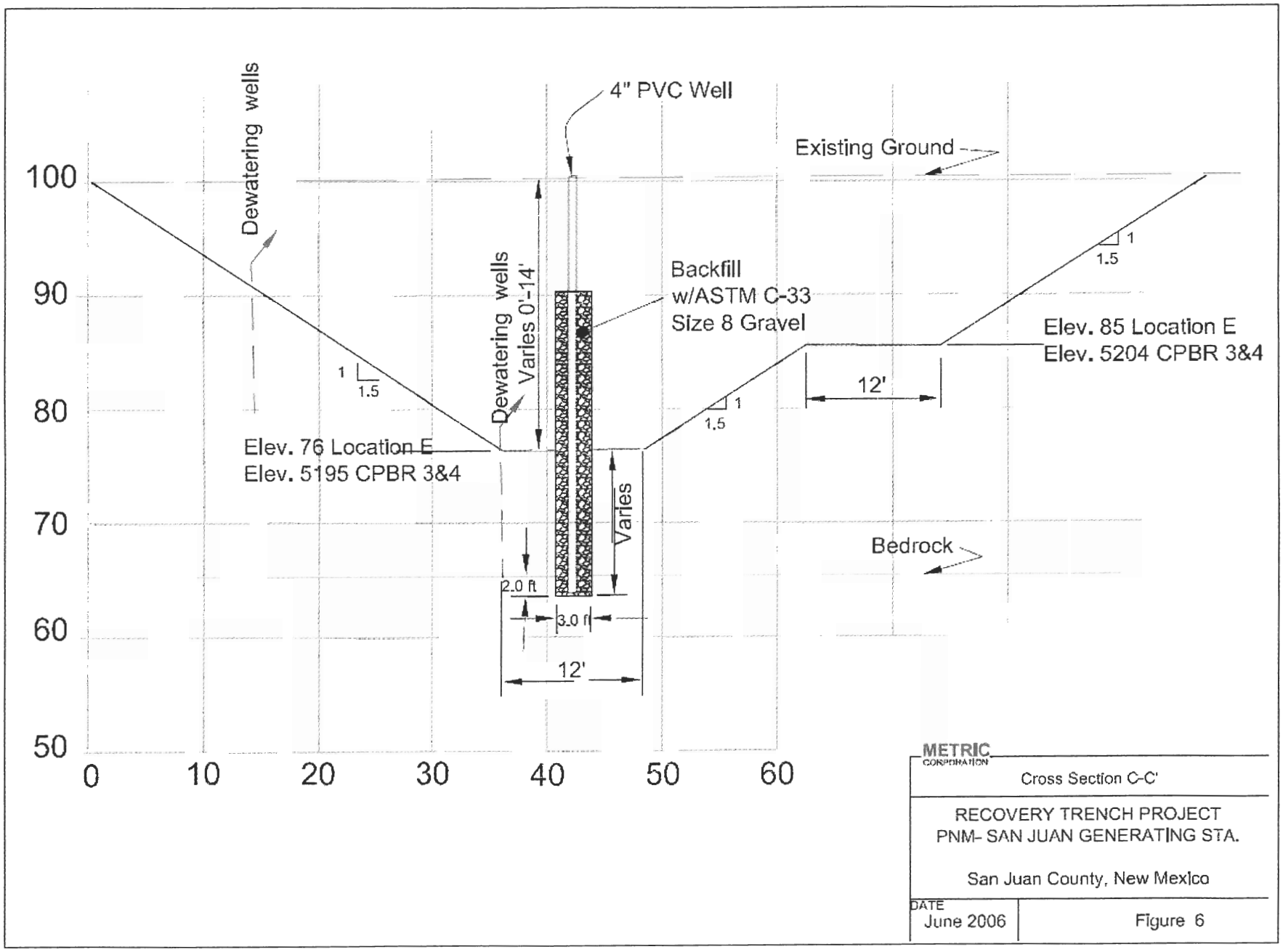
San Juan County, New Mexico

DATE
June 2006

Figure 4



METRIC CORPORATION	
Cross Section B-B'	
RECOVERY TRENCH PROJECT PNM- SAN JUAN GENERATING STA. San Juan County, New Mexico	
DATE June 2006	Figure 5



METRIC CORPORATION

Cross Section C-C'

RECOVERY TRENCH PROJECT
PNM- SAN JUAN GENERATING STA.

San Juan County, New Mexico

DATE June 2006

Figure 6

TABLE 1

Sampling Point Water Level Elevations San Juan Generating Station 9/27/2006	
Qnt @ QNT	5222
Qnt @ QAL-3	5219
Qnt @ QAL-2	5217
Qnt @ QAL-1	5203
Qnt @ MW-4	5196
Kpc @ Kpc	5237
QAL-1 (Qal)	5212
QAL-2 (Qal)	5235
QAL-3 (Qal)	5250
MW-4 (Qal)	5253

TABLE 2

Water Chemistry Summary
San Juan Generating Station
9/27/2006

Source	Cl	NO3
KPC	360	<.02
LAKE	17	0.1
ABSORBER	4276	178
TOWER 1&2	168	2.07
TOWER 4	172	1.98
PP COMP	150	4 av.
NEP	266,000	1400
TOWER 3	83	0.88
SS TREATMENT	71	48.4
C RECLAIM	126	9.57
Sampling Point		
QAL-1	320	30.3
QAL-2	230	26.7
QAL-3	290	32.2
MW 4	82	5.92

TABLE 3

Indicated Sources for Groundwater Samples
San Juan Generating Station
9/20/06

Sampling Point	Indicated Source	Estimated Contribution	Geometry	Trilinear Diagram	Cl Well	Cl Source	No3 Well	No3 Source
QAL-3					290		32.2	
	TOWER 4	Major	Y	Y		172		1.98
	KPC	Major	Y	Y		360		0.01
	Absorber	Minor	Y	Y		4276		178
QAL-2					230		26.7	
	C Reclaim	Major	Y	Y		126		9.57
	SS Treatment	Major	Y	Y		71		48.4
	KPC	Major	Y	Y		360		0.01
	Absorber	Minor	Y	Y		4276		178
QAL-1					320		30.3	
	SS Treatment	Major	Y	Y		71		48.4
	CPRB 1&2	Major	Y	Y		560		<.02
	KPC	Major	Y	Y		360		0.01
	Absorber	Minor	Y	Y		4676		178
MW-4					82		5.92	
	LAKE	Major	Y	Y		17		0.1
	TOWER 1&2	Major	Y	Y		168		2.02
	SS Treatment	Major	Y	Y		71		48.4
	Absorber	Minor	Y	Y		4676		178

TABLE 4
Plant Activities to Address Ground Water Impacts
San Juan Generating Station
10-10-06

Number	Activity	Location	Purpose	Status	Comments
1	Install ground water recovery trench	Below plant property in Shumway Arroyo above the Dunlap Farm	Recovery of groundwater coming from plant site	Proposed priority	Expected to capture 95-100% of ground water coming from plant site.
2	Clean, inspect & repair leaks Pond #3 liner	Process Pond #3	Eliminate leakage	Priority	Possible source of leakage to ground water.
3	Inspect all cooling towers on a daily basis and address leaks as priority 1&2	Cooling Towers #1 through 4	Mitigate leakage	Priority	Towers inspected - continue with repairs, possible source of leakage to ground water.
4	Inspect and repair sanitary man holes through-plant for potential leaks.	Specific emphasis on north side of plant	Identify leaks	Priority	Manhole leakage could be cause of elevated nitrates (above WQCC Stds) in northern area of plant.
5	Inspect & repair Unit #1 & 2 Cooling Tower and water lines	Unit #1, 2 & 3 Cooling Tower and Water Lines	Eliminate leakage	Ongoing- outage item	Tower and lines are inspected every outage and repairs made if possible.
6	Inspect & repair Unit #3 Cooling Tower & water lines	Unit #3 Cooling Tower	Eliminate leakage	In progress	Tower and lines are inspected every outage. 420 linear feet of line (out of 2000 feet) was relined in April 2006. Project will continue during major outages.

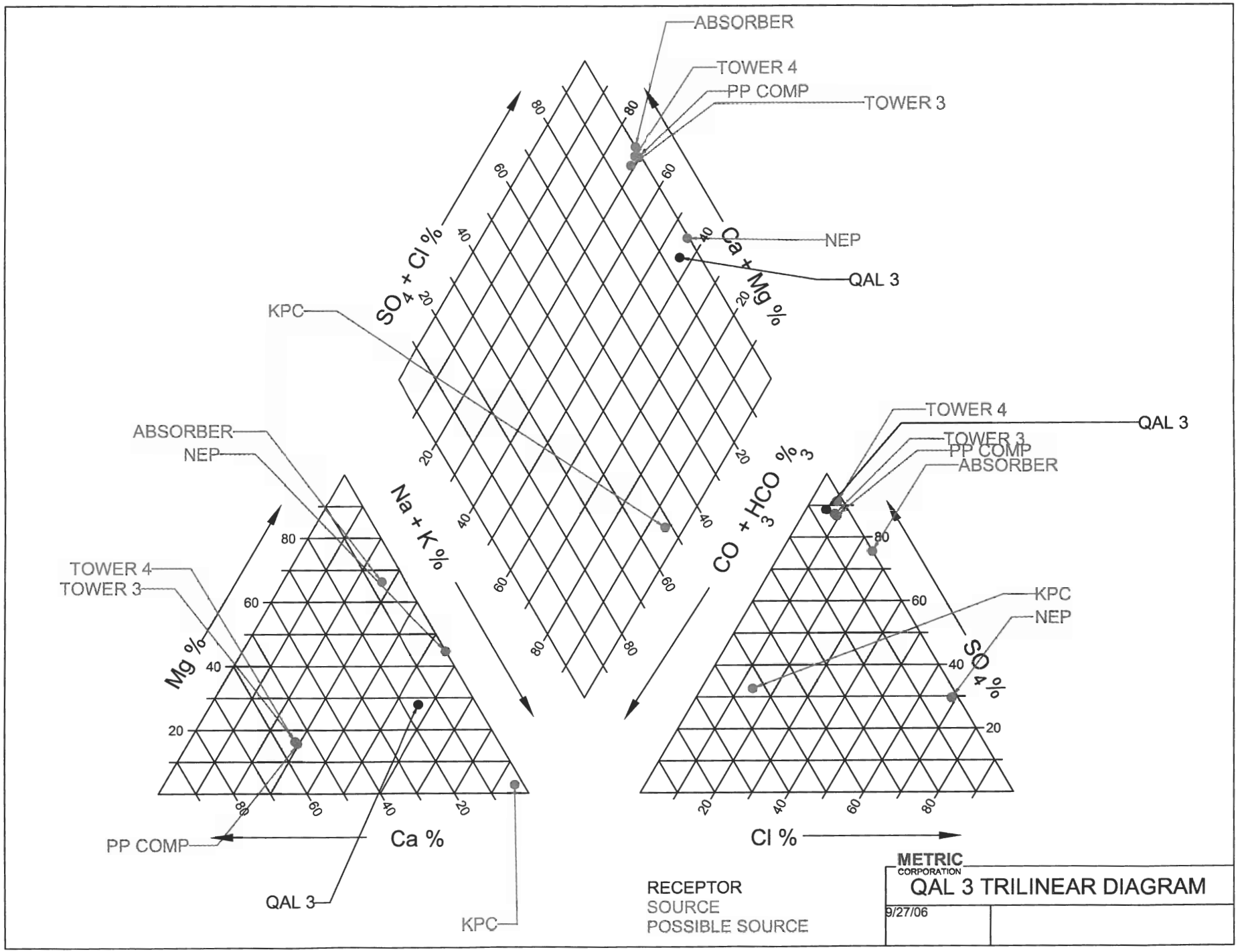
TABLE 4
Plant Activities to Address Ground Water Impacts
San Juan Generating Station
10-10-06

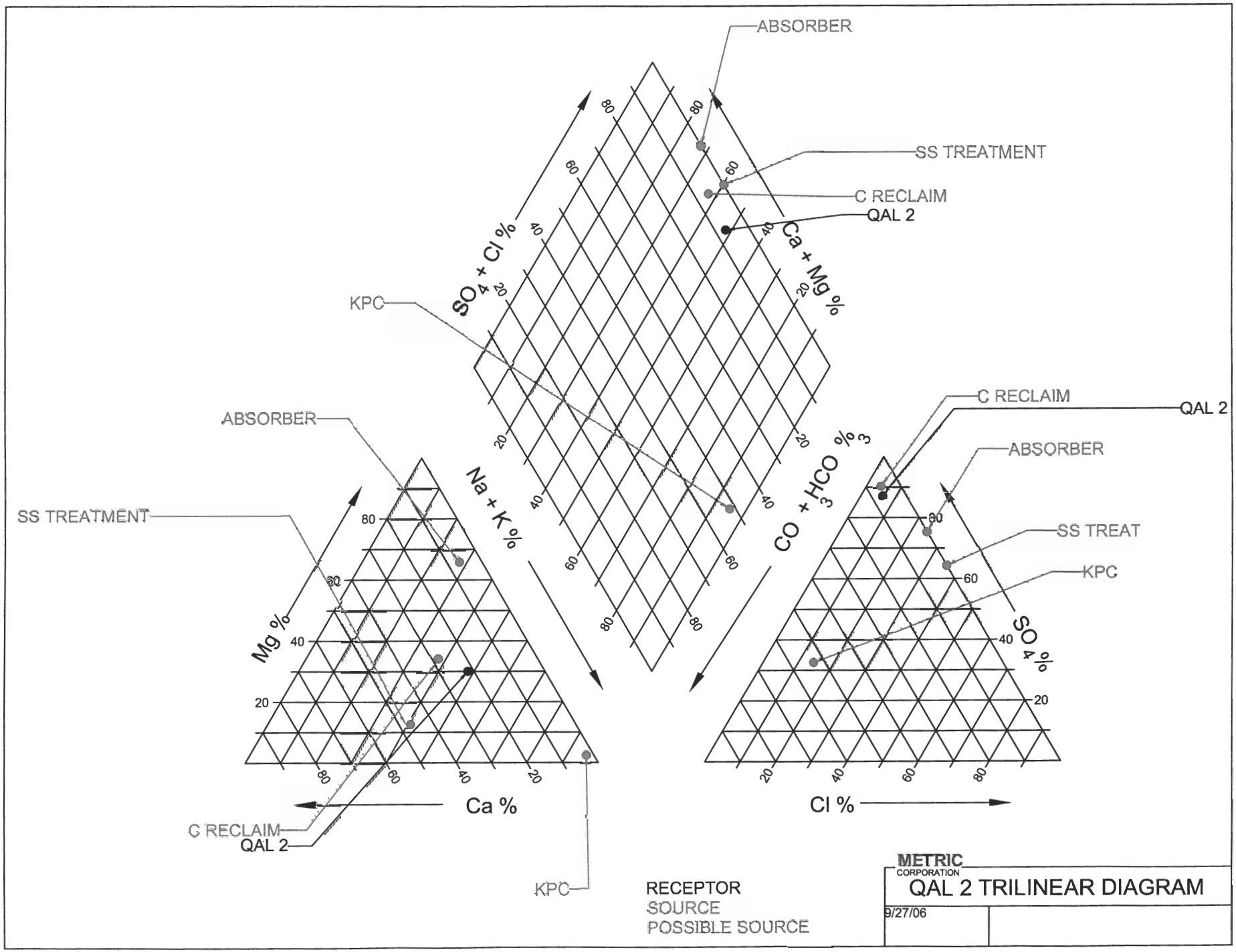
Number	Activity	Location	Purpose	Status	Comments
7	Inspect & repair Unit #4 Cooling Tower & water lines	Unit #4 Cooling Tower	Eliminate leakage	In progress	Tower and lines are inspected every outage. 240 linear feet of line (out of 4800 feet) was relined in April 2006. Project will continue during major outages.
8	Monthly sampling for 1 year as stated in July 2003 GW investigation	Existing MWs; Qnt-1, Kpc-1 & Qnt-2; Qal 1, 2, 3; Tower 1&2, Tower 3, Tower 4; CPRB-1 & 2, CPRB-3 & 4; and process ponds	Obtain further information on background water quality, monitor water quality and sources of water	In progress	Monthly sampling ongoing. Scheduled for completion December 2006.
9	Clean Pond #1	Pond #1	Stop bypass water from 1A to 1B	In progress	Pond cleaning in progress (August 2006). Completion date not yet known.
10	Sample process water locations throughout plant	Various	Possible source identification of ground water leakage	In progress	Surface impoundments and waste water facilities continue to be evaluated for possible link to ground water contamination.
11	Install Qnt-1	NE of N. Evap Pond #3	Verify background water quality	Completed	Well installed.

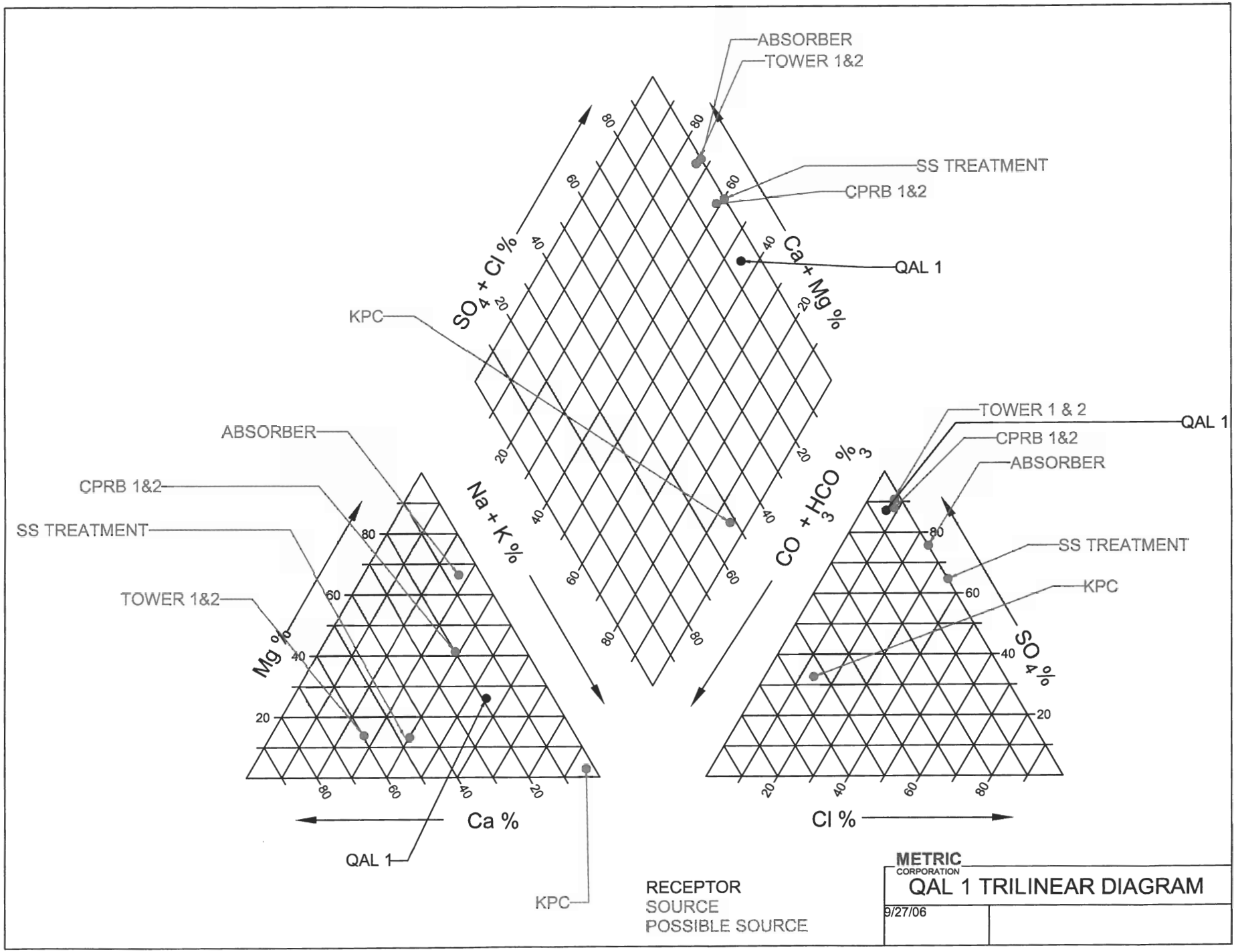
TABLE 4
Plant Activities to Address Ground Water Impacts
San Juan Generating Station
10-10-06

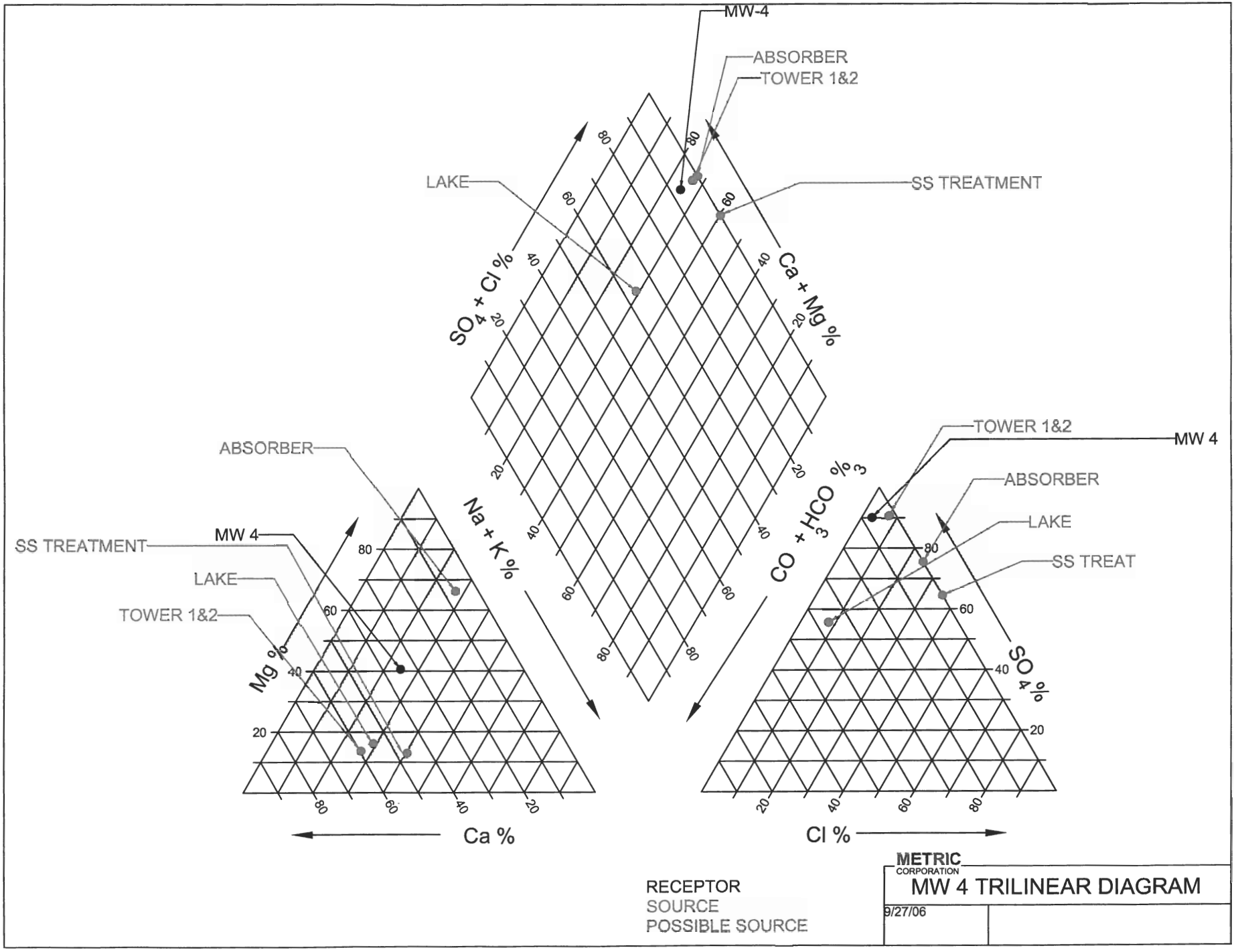
Number	Activity	Location	Purpose	Status	Comments
12	Install Kpc-1	Between Process Pond #3 & N. Evap Pons	Verify background water quality & verify Kpc's contribution to monitor wells in the area	Completed	Well installed.
13	Install Qnt-2	E. of CPRB-1&2	Monitor leakage from CPRB-1&2	Completed	Well installed.
14	Route water from coal reclaim sumps to process pond (could dry up CPRB 3&4)	As stated	Eliminate/minimize water source to CPRB 3&4	Completed	Sump installed in February 2006. Controls upgraded and operational June 2006.
15	Reroute or pump crusher wash down water and unit #1 & 2 reclaim sumps to process ponds	Unit #1 & 2	Eliminate potential source to groundwater	Completed	Sump installed in February 2006. Controls upgraded and operational June 2006.
16	Install synthetic liner in CPRB 3&4	CPRB 3&4	Eliminate leakage	In Capital Budget 2008	Added to Capital Budget Items for 2008.
17	Install synthetic liner in CPRB #1 &2	CPRB #1 & 2	Eliminate leakage	In Capital Budget 2008	Added to Capital Budget Items for 2008.

APPENDIX A


ABSORBER
TOWER 4
PP COMP
TOWER 3
NEP
QAL 3
KPC
SO4 + Cl %
Ca + Mg %
Na + K %
CO3 + HCO3 %
Mg %
Ca %
Cl %
SO4 %
20
40
60
80
RECEPTOR
SOURCE
POSSIBLE SOURCE
METRIC CORPORATION
QAL 3 TRILINEAR DIAGRAM
9/27/06


ABSORBER
SS TREATMENT
C RECLAIM
QAL 2
KPC
SO_4 + Cl %
Ca + Mg %
Na + K %
CO_3 + HCO_3 %
ABSORBER
C RECLAIM
QAL 2
SS TREATMENT
ABSORBER
SS TREAT
KPC
Mg %
Ca %
Cl %
SO_4 %
C RECLAIM
QAL 2
KPC
RECEPTOR
SOURCE
POSSIBLE SOURCE
METRIC
CORPORATION
QAL 2 TRILINEAR DIAGRAM
9/27/06


ABSORBER
TOWER 1&2
SS TREATMENT
CPRB 1&2
QAL 1
KPC
SO4 + Cl %
Ca + Mg %
Na + K %
CO3 + HCO3 %
Mg %
Ca %
Cl %
SO4 %
TOWER 1 & 2
RECEPTOR
SOURCE
POSSIBLE SOURCE
METRIC CORPORATION
QAL 1 TRILINEAR DIAGRAM
9/27/06


MW-4
ABSORBER
TOWER 1&2
LAKE
SS TREATMENT
SO4 + Cl %
Ca + Mg %
Na + K %
CO3 + HCO3 %
ABSORBER
MW 4
SS TREATMENT
LAKE
TOWER 1&2
Mg %
Ca %
TOWER 1&2
MW 4
ABSORBER
LAKE
SS TREAT
SO4 %
Cl %
RECEPTOR
SOURCE
POSSIBLE SOURCE
METRIC
CORPORATION
MW 4 TRILINEAR DIAGRAM
9/27/06

PRELIMINARY INVESTIGATION INTO THE HYDROLOGIC CHARACTERISTICS OF THE WESTWATER AND SHUMWAY ARROYOS IN THE VICINITY OF THE SAN JUAN GENERATING STATION SAN JUAN COUNTY, NEW MEXICO

PREPARED FOR
PUBLICE SERVICE COMPANY OF NEW MEXICO
ALBUQUERQUE, NEW MEXICO

PREPARED BY
METRIC CORPORATION
LOS LUNAS, NEW MEXICO

APRIL 2006

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INTRODUCTION

Between March 2005 and February 2006 METRIC Corporation and Public Service Company of New Mexico's San Juan Generating Station personnel conducted an investigation to evaluate the hydrologic characteristics of the Westwater and Shumway Arroyos in the vicinity of the San Juan Generating Station. Flow measurements were made at 13 stations along the arroyos on a monthly basis, and water samples were collected and analyzed at four of the stations on a monthly basis, when water was present. The investigation design, data analysis and report preparation were conducted by METRIC Corporation. The fieldwork (i.e. flow measurements and water sample collections) were performed by San Juan Generating Station personnel. The water sample analyses were performed by Green Analytical Laboratory in Durango, Colorado.

SURFACE WATER FLOW MEASUREMENTS

Flow measurements were made at 13 stations (S-1 to S-13 on FIGURE 1) along an approximate four-mile long reach of the Westwater and Shumway Arroyos. The flow measurements were made using a standard USGS mini-current meter and a standard wading rod. The velocity area method was used. Velocity measurements were taken at 0.6 of the total depth below the water surface as described in USGS, 1977. The 13 flow measurement stations shown on FIGURE 1 are described as follows:

- Station S-1 is located in the redirected Westwater Arroyo channel just downstream from the haul road crossing. This section is upstream from most San Juan Generating Station activity and downstream from some San Juan Mine activities, notably Pinon Pit.

- Station S-2 is located in the Westwater Arroyo diversion just upstream from its confluence with the Shumway Diversion.

- Station S-3 is located in the Shumway Diversion just upstream from its confluence with the Westwater Diversion.

- Station S-4 is located at the upstream edge of a seep occasionally observed in the Shumway Diversion.

- Station S-5 is located just upstream from the La Plata haul road crossing in the Shumway Diversion.

- Station S-6 is located in the Westwater Arroyo at the San Juan Mine irrigation water pipeline crossing.

- Station S-7 is located in the Raw Water Reservoir Arroyo just upstream fro its confluence with the Westwater Arroyo.

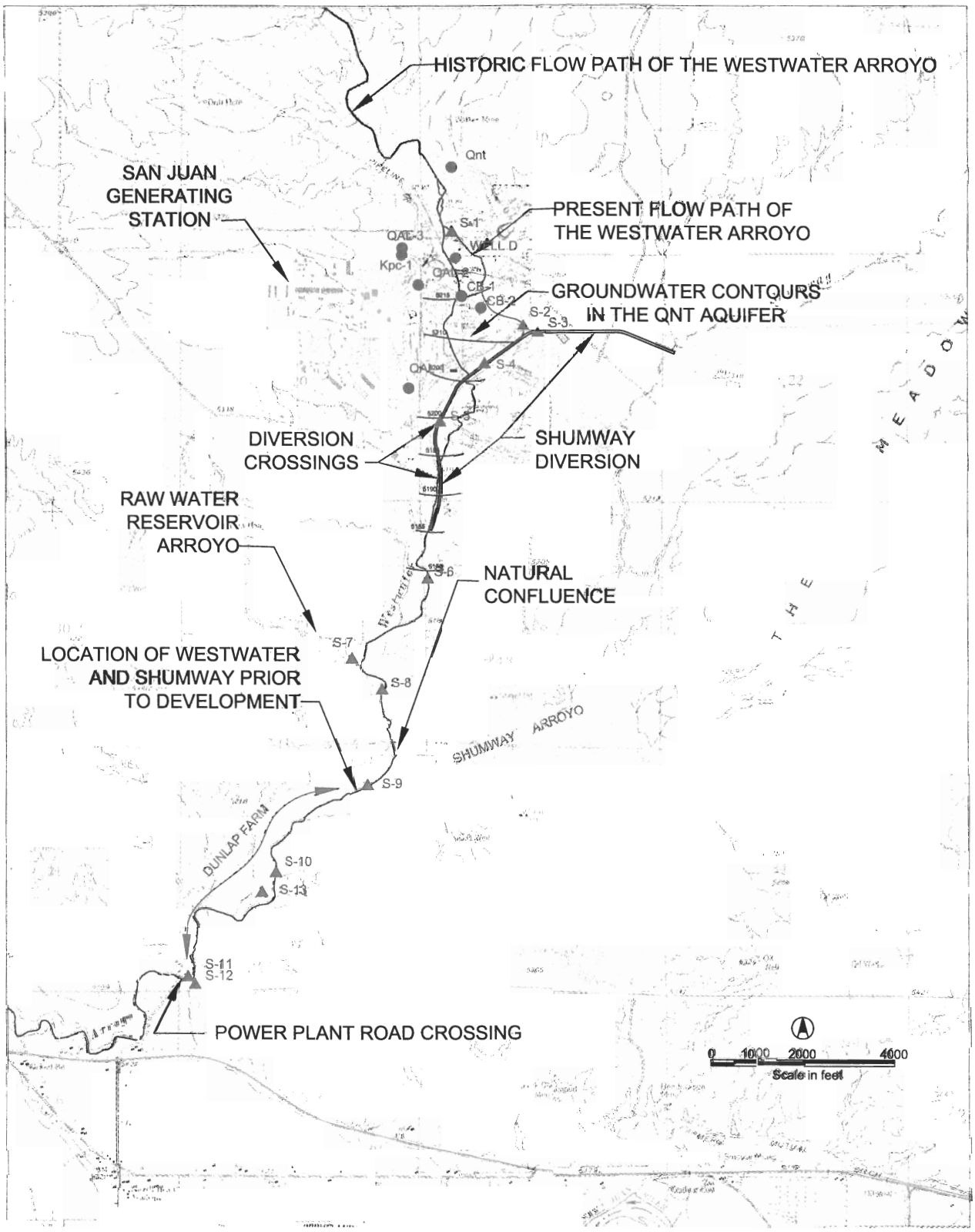

FIGURE 1
MONITORING STATION LOCATION MAP
WESTWATER AND SHUMWAY ARROYO
HYDRAULIC INVESTIGATION

- Station S-8 is located in the Westwater Arroyo just downstream from the red gravel road crossing.

- Station S-9 is located in the Shumway Arroyo at the upstream edge of the Dunlap Farm.

- Station S-10 is located in the Shumway near the middle of the Dunlap Farm.

- Station S-11 is located in the Shumway Arroyo at the downstream edge of the Dunlap Farm and just upstream from Power Plant Road Crossing.

- Station S-12 is located in the Farmers Mutual Ditch Wastewater. This flow is included in the measurements made at S-11.

- Station S-13 is located in the Wasteway from the Dunlap Farm irrigation storage reservoir. This flow is included in the measurements made at S-11.

The results of the 12 monthly flow measurement surveys are summarized in TABLE 1. The field measurements and calculations are presented in APPENDIX A. In TABLE 1 a "DRY" entry indicates no water was present, whereas "0.00" entry indicates there was standing water but it was not perceptibly flowing.

ARROYO WATER QUALITY SAMPLING

Water samples were collected at four of the stations (S-4, S-5, S-8 and S-11) when water was present. The samples were preserved and sent to Green Analytical Laboratory for analysis of major ions, metals, TDS, Conductivity, Nitrate, pH and phenols. The analytical results are summarized in TABLE 2.

CONCLUSIONS RESULTING FROM FLOW MEASUREMENTS

Based on the flow measurements conducted during the preceding 12 months (TABLE 1), the upper reaches of the Westwater Arroyo (S-1 and S-2) and the upper reaches of the Shumway Diversion (S-3) are characterized as ephemeral streams (i.e., they flow only in direct response to precipitation events). The reach of the Shumway Diversion represented by S-4 may be characterized as an ephemeral or perhaps intermittent stream (i.e. it flows seasonably). The lower reach of the Shumway Diversion represented by S-5 and the reach of the Westwater Arroyo represented by S-6 are characterized as intermittent streams. They exhibit seasonal flow.

TABLE 1
PUBLIC SERVICE COMPANY OF NEW MEXICO
SAN JUAN GENERATING STATION

SHUMWAY ARROYO DISCHARGE FLOW MEASUREMENT SUMMARY

DATE	S1 WESTWATER @ HAUL ROAD		S2 WESTWATER @ DIVERSION		S3 DIVERSION UPSTREAM FROM WESTWATER		S4 DIVERSION SEEP		S5 DIVERSION @ BRIDGE		S6 WESTWATER @ PIPELINE		S7 RAW WATER RESERVOIR ARROYO		S8 RED BRICK ROAD		S9 UPSTREAM @ DUNLAP FARM		S10 MIDDLE @ DUNLAP FARM		S11 MEASURED DOWNSTREAM @ DUNLAP FARM		S11-S13= S11 ACTUAL		S12 DITCH OVERFLOW		S13 IRRIGATION RETURN FLOW		S11-S12
	(cfs)	(gpm)	(cfs)	(gpm)	(cfs)	(gpm)	(cfs)	(gpm)	(cfs)	(gpm)	(cfs)	(gpm)	(cfs)	(gpm)	(cfs)	(gpm)	(cfs)	(gpm)	(cfs)	(gpm)	(cfs)	(gpm)	(cfs)	(gpm)	(cfs)	(gpm)	(cfs)	(gpm)	(gpm)
3/16/05	DRY	DRY	DRY	DRY	DRY	DRY	0.00	0.00	0.04	17.95	0.02	8.98	0.00	0.00	0.08	35.90	0.06	26.93	0.07	31.42	0.13	58.34	0.13	58.34	DRY	DRY	DRY	DRY	58.344
4/19/05	DRY	DRY	DRY	DRY	DRY	DRY	0.00	0.00	0.04	17.95	0.04	17.95	0.02	8.98	0.07	31.42	0.05	22.44	0.07	31.42	0.54	242.35	0.54	242.35	0.28	125.66	DRY	DRY	116.69
5/18/05	DRY	DRY	DRY	DRY	DRY	DRY	0.00	0.00	0.03	13.46	0.05	22.44	0.00	0.00	0.05	22.44	0.02	8.98	0.13	58.34	0.56	251.33	0.56	251.33	0.09	40.39	DRY	DRY	210.94
6/15/05	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	0.03	13.46	0.01	4.49	0.00	0.00	0.00	0.00	0.00	0.00	0.11	49.37	0.71	318.65	0.69	309.67	0.08	35.90	DRY	DRY	282.74
7/14/05	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	0.00	0.00	0.00	0.00	DRY	DRY	DRY	DRY	DRY	DRY	0.06	26.93	0.69	309.67	0.69	309.67	DRY	DRY	DRY	DRY	309.67
8/17/05	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	0.00	0.00	0.00	0.00	DRY	DRY	DRY	DRY	DRY	DRY	0.09	40.39	0.55	246.84	0.16	71.81	DRY	DRY	0.39	175.03	246.84
9/21/05	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	0.03	13.46	0.00	0.00	DRY	DRY	DRY	DRY	DRY	DRY	0.09	40.39	0.40	179.52	0.40	179.52	DRY	DRY	DRY	DRY	179.52
10/18/05	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	0.03	13.46	0.01	4.49	DRY	DRY	0.02	8.98	0.00	0.00	0.07	31.42	0.46	206.45	0.46	206.45	DRY	DRY	DRY	DRY	206.45
11/16/05	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	0.04	17.95	0.02	8.98	DRY	DRY	0.08	35.90	0.01	4.49	0.07	31.42	0.51	228.89	0.51	228.89	DRY	DRY	DRY	DRY	228.89
12/13/05	DRY	DRY	DRY	DRY	DRY	DRY	0.00	0.00	0.03	13.46	0.02	8.98	DRY	DRY	0.08	35.90	0.01	4.49	0.07	31.42	0.43	192.98	0.51	228.89	DRY	DRY	DRY	DRY	192.98
1/19/06	DRY	DRY	DRY	DRY	DRY	DRY	0.00	0.00	0.03	13.46	0.02	8.98	DRY	DRY	0.08	35.90	0.01	4.49	0.07	31.42	0.41	184.01	0.51	228.89	DRY	DRY	DRY	DRY	184.01
2/14/06	DRY	DRY	DRY	DRY	DRY	DRY	0.00	0.00	0.03	13.46	0.02	8.98	DRY	DRY	0.08	35.90	0.01	4.49	0.07	31.42	0.43	192.98	0.51	228.89	DRY	DRY	DRY	DRY	192.98

TABLE 2
SHUMWAY ARROYO WATER QUALITY DATA SUMMARY
PUBLIC SERVICE COMPANY OF NEW MEXICO
SAN JUAN GENERATING STATION

Na mg/L	Bicarb. mg/L	Carb. mg/L	Cl mg/L	F mg/L	SO4 mg/L	Al mg/L	As mg/L	Ba mg/L	B mg/L	Cd mg/L	Cr mg/L	Co mg/L	Cu mg/L	Fe mg/L	Pb mg/L	Mn mg/L	Hg mg/L	Mo mg/L	Ni mg/L	Se mg/L	Ag mg/L	U mg/L	Zn mg/L
740	610	<10	2920	0.6	10600	<0.10	0.008	0.044	1.9	<0.00005	0.032	0.009	0.146	<0.05	0.002	1.725	<0.0002	0.014	0.113	0.025	0.00038	0.086	0.024
980	450	200	5200	0.8	25000	<0.10	0.019	0.025	3.4	<0.00005	<0.01	0.006	0.217	0.05	<0.001	0.405	<0.0002	0.014	0.156	0.09	<0.005	0.054	0.02
900	780	40	5300	0.7	26500	<0.10	0.03	0.057	4.2	<0.0005	0.05	0.006	0.182	0.08	<0.001	1.762	<0.0002	0.033	0.166	0.08	0.0013	0.038	<0.01
420	785	80	3190	0.6	10900	<0.10	0.022	<0.0001	1.9	<0.00005	0.023	<0.00005	0.003	<0.05	0.001	<0.00005	<0.0002	0.001	<0.0005	<0.001	0.0001	0.0003	0.002
Na	Bicarb.	Carb.	Cl	F	SO4	Al	As	Ba	B	Cd	Cr	Co	Cu	Fe	Pb	Mn	Hg	Mo	Ni	Se	Ag	U	Zn
100	560	20	730	0.8	6000	<0.10	0.003	0.022	2.8	<0.00005	0.025	0.008	0.057	<0.05	0.001	0.122	<0.0002	0.003	0.084	0.021	0.00006	0.049	0.012
120	510	20	770	0.8	6100	<0.10	<0.005	0.016	2.8	<0.0005	<0.01	0.007	0.063	<0.05	<0.001	0.074	<0.0002	0.003	0.083	0.03	<0.0005	0.04	<0.01
900	505	<10	640	0.8	5700	<0.10	0.003	0.028	2.7	<0.0005	0.04	0.005	0.036	<0.05	<0.001	0.299	<0.0002	0.008	0.078	0.02	0.0005	0.029	<0.01
470	610	<10	760	0.9	6300	<0.10	0.005	0.03	2.8	<0.00005	0.042	0.005	0.03	<0.05	0.0001	0.413	<0.0002	0.002	0.069	0.022	<0.00005	0.043	0.008
230	620	<10	730	0.9	6100	<0.10	0.005	0.03	4.4	<0.00005	0.021	0.005	0.052	<0.05	0.0003	0.387	<0.0002	0.003	0.074	0.018	<0.00005	0.032	0.009
380	500	<10	465	0.8	3350	<0.10	0.003	0.16	1.9	<0.00005	0.015	0.005	0.016	<0.05	<0.0001	0.387	<0.0002	0.003	0.046	0.012	0.0006	0.017	0.003
850	520	<10	660	0.7	5200	<0.10	0.002	0.04	2.5	<0.00005	0.19	0.005	0.056	<0.05	<0.0001	0.038	<0.0002	<0.00005	0.094	0.017	0.0002	0.029	0.003
140	492	16	520	0.7	5400	0.2	0.008	0.06	2.3	0.00008	0.05	0.005	0.026	<0.05	<0.0001	0.135	<0.0002	0.001	0.053	0.058	<0.00005	0.023	0.009
000	562	12	740	0.8	6200	<0.10	0.003	0.023	3.3	0.0001	0.048	0.006	0.028	<0.05	0.0002	0.121	<0.0002	0.002	0.076	0.021	0.0001	0.042	0.008
170	650	<10	740	0.9	6200	<0.10	0.004	0.022	2.4	<0.00005	0.026	0.009	0.051	<0.05	0.0001	0.28	<0.0002	0.004	0.084	0.028	<0.00005	0.05	0.007
230	660	20	750	0.8	5700	<0.10	0.004	0.017	3	<0.00005	0.029	0.007	0.038	<0.05	0.0003	0.172	<0.0002	<0.00005	0.038	0.024	<0.00005	0.045	0.013
990	550	20	650	0.8	5200	<0.10	0.009	0.018	2.6	0.001	0.042	0.006	0.061	<0.05	0.0003	0.095	<0.0002	0.007	0.129	0.047	0.00007	0.039	0.011
Na	Bicarb.	Carb.	Cl	F	SO4	Al	As	Ba	B	Cd	Cr	Co	Cu	Fe	Pb	Mn	Hg	Mo	Ni	Se	Ag	U	Zn
590	455	10	540	1	6000	<0.10	0.003	0.025	1.7	<0.00005	0.014	0.009	0.038	<0.05	0.001	0.251	<0.0002	0.003	0.085	0.026	<0.00005	0.04	0.012
580	395	10	570	1.1	6100	<0.10	<0.005	0.018	1.8	<0.0005	<0.01	0.008	0.039	<0.05	0.001	0.323	<0.0002	0.004	0.092	0.03	<0.0005	0.029	<0.01
590	410	<10	540	1.1	6400	<0.10	<0.005	0.026	2.1	<0.0005	0.03	0.006	0.03	<0.05	<0.001	0.506	0.0003	0.006	0.093	0.02	<0.0005	0.023	<0.01
63	306	<10	220	0.6	3350	<0.10	0.002	0.026	0.8	<0.00005	0.019	0.003	0.011	<0.05	<0.0001	0.266	<0.0002	0.002	0.042	0.009	<0.00005	0.016	0.007
700	378	44	460	0.8	4800	0.14	0.007	0.151	1.7	0.00005	0.039	0.004	0.025	<0.05	<0.001	0.009	<0.0002	0.002	0.059	0.057	<0.00005	0.018	0.009
440	280	20	304	0.6	3320	<0.10	0.001	0.052	1.4	0.00007	0.029	0.003	0.015	<0.05	0.0001	0.013	<0.0002	0.002	0.048	0.012	0.00006	0.02	0.006
35	300	<10	150	0.4	2880	<0.10	0.002	0.047	0.5	<0.00005	<0.001	0.002	0.015	<0.05	0.0002	0.274	<0.0002	0.024	0.037	0.011	<0.00005	0.018	0.011
070	346	<10	312	0.6	2950	<0.10	0.001	0.038	1.2	<0.00005	0.018	0.004	0.012	<0.05	0.0001	0.09	<0.0002	0.001	0.049	0.014	<0.00005	0.022	0.008
51	320	<10	268	0.6	3150	<0.10	0.004	0.045	0.9	0.0005	0.028	0.004	0.027	<0.05	0.0002	0.112	<0.0002	0.001	0.1	0.026	0.00006	0.017	0.007
Na	Bicarb.	Carb.	Cl	F	SO4	Al	As	Ba	B	Cd	Cr	Co	Cu	Fe	Pb	Mn	Hg	Mo	Ni	Se	Ag	U	Zn
94	396	<10	258	0.7	3000	<0.10	0.002	0.059	0.6	<0.00005	0.008	0.003	0.017	<0.05	0.001	1.07	<0.0002	0.003	0.028	0.005	<0.00005	0.02	0.013
57	129	<10	62	0.3	560	<0.10	<0.005	0.077	0.5	<0.0005	<0.01	0.0005	0.005	<0.05	<0.001	0.101	0.002	0.002	0.008	<0.01	<0.0005	0.003	0.02
21	270	<10	183	0.5	1560	<0.10	<0.005	0.06	0.4	<0.0005	0.02	<0.0005	0.011	<0.05	<0.001	0.504	<0.0002	0.004	0.013	<0.01	<0.0005	0.007	<0.01
15	264	<10	159	0.5	1850	<0.10	0.002	0.052	0.2	<0.00005	0.019	0.001	0.007	<0.05	<0.0001	0.208	<0.0002	0.002	0.014	0.004	<0.00005	0.01	0.004
58	318	<10	104	0.5	1320	<0.10	0.002	0.059	0.7	<0.00005	0.014	0.001	0.011	<0.05	<0.0001	0.305	<0.0002	0.002	0.011	0.004	<0.00005	0.01	0.003
38	310	<10	145	0.7	1320	<0.10	0.04	0.051	0.4	<0.00005	0.01	0.0009	0.001	<0.05	0.0003	0.27	<0.0002	0.194	0.011	0.002	0.00024	0.008	0.04
10	460	<10	121	0.7	1580	<0.10	0.001	0.094	0.3	<0.00005	0.26	0.0009	0.013	<0.05	<0.0001	0.643	<0.0002	<0.00005	<0.0005	0.002	0.00017	0.011	<0.001
61	280	<10	62	0.5	940	0.2	0.006	0.075	0.3	<0.00005	0.027	0.001	0.008	<0.05	<0.0001	0.366	<0.0002	0.001	0.006	0.037	<0.00005	0.005	0.008
090	455	<10	236	0.8	2370	<0.10	0.001	0.068	0.6	0.00006	0.043	0.002	0.011	<0.05	<0.0001	0.577	<0.0002	0.002	0.022	0.004	<0.00005	0.022	0.005
07	570	<10	280	0.8	2950	<0.10	0.002	0.049	0.5	<0.00005	0.001	0.002	0.012	<0.05	<0.0001	0.612	<0.0002	0.016	0.031	0.01	<0.00005	0.025	0.009
83	505	<10	278	0.7	2850	<0.10	0.0009	0.031	0.6	<0.00005	0.025	0.002	0.015	<0.05	<0.0001	0.593	<0.0002	0.002	0.029	0.004	<0.00005	0.022	0.005
62	470	<10	260	0.7	2900	<0.10	0.003	0.034	0.5	0.00059	0.028	0.004	0.021	<0.05	0.0001	0.392	<0.0002	0.001	0.133	0.015	0.00005	0.017	0.005

METRIC Corporation's investigations of the Westwater and Shumway drainages conducted between 1981 and 1984 established the presence of a naturally occurring linear aquifer within the unconsolidated sediments, (Qnt and Qal) of those two drainages. That aquifer passes along the east side of the San Juan Generating Station, (see FIGURE 1).

From 1987 to 1999, METRIC Corporation conducted 12 annual inspections of the entire length of the Shumway and Westwater Diversions for San Juan Coal Company. The purpose of the inspections was to monitor erosion occurring in the diversion. During those inspections, we noted a reach of the diversion from the bridge upstream for a distance of about 700 ft. where flow was generally visible. In that 700 ft. reach of the diversion we also noted scour had lowered the channel bottom 2 ft. to 7 ft. below the original constructed elevations.

It is our opinion that the flow in this reach of the Shumway Diversion is the result of the diversion bottom having been excavated to elevations lower than the naturally occurring water table in the sediments into which the diversion was constructed. The scour, which has occurred in the diversion channel bottom, has further exposed the water table. It is our opinion that the observed flows at S-4, S-5 are the result of the excavation and subsequent erosion in the Shumway Diversion having exposed the alluvial water table in those areas.

It is possible that erosion in the Westwater Arroyo has also exposed the water table at Station S-6. Station S-7 represents conditions in the lower reach of the Raw Water Reservoir Arroyo upstream from the Westwater Arroyo. This reach may be ephemeral or intermittent. During March, April May and June 2005 water was present at this station. Subsequent to June 2005, it was dry. Several beaver ponds were drained in the area near the downstream slope of the Raw Water Reservoir dam in December 2004 and again in January 2006. If the beaver ponds can be kept drained, this reach may remain ephemeral.

The reach of the Westwater Arroyo represented by Station S-8 and the reach of the Shumway Arroyo represented by S-9 appear to be intermittent streams. It is possible that the water table may be above the arroyo bottom seasonally, or there may be some other explanation. The reach of the lower Shumway Arroyo represented by Stations S-10 and S-11 are characterized as a perennial reach (i.e. the stream flows throughout the year). The principal source of the perennial flow is irrigation return flow resulting from application of irrigation water to the Dunlap Farm (FIGURE 1). The existence of a series of beaver dams throughout this reach help to ensure that the reach flows throughout the year. According to LaRay Collyer, May 23, 2003, personal communication, irrigation at the Dunlap Farm began in the late 1960's (probably 1967). Earlier aerial photos of the area indicate this reach of the Shumway Arroyo was ephemeral before that date.

Flows, which occur at Stations S-12 and S-13, are the direct result of irrigation being wasted back to the Arroyo during the irrigation season.

CONCLUSIONS RESULTING FROM ARROYO WATER QUALITY ANALYSES

The Qnt aquifer is a linear saturated unconsolidated deposit, which generally follows the historic flow path of the Westwater Arroyo and then the flow path of the Shumway Arroyo downstream from the natural confluence (FIGURE 1). The aquifer is about 1000 feet wide and 20 feet thick in the vicinity of the San Juan Generating Station.

Based on the geometry of the saturated unconsolidated deposits (i.e., Qnt and Qal) wells Qnt, Well D, CB-1, and CB-2 and surface water sampling sites S-4 and S-5 are along the groundwater flow path in the Qnt aquifer from upstream to downstream. Wells Qal-3, 2 and 1 are completed in groundwater tributaries to the Qnt aquifer, which enter from the west, the area where the San Juan Generating Station is located. Qal-3 samples a groundwater tributary, which enters the Qnt aquifer between wells Qnt and Well D. Qal-2 samples a groundwater tributary, which enters the Qnt aquifer between wells Well D and CB-1. Qal-1 samples a groundwater tributary, which enters the Qnt aquifer between S-4 and S-5.

Recent water quality data for the monitoring wells and surface water sampling sites discussed above have been plotted on FIGURE 2. The supporting water quality data is in APPENDIX B. A preliminary analysis of FIGURE 2 suggests that the waters at Well D, CB-1, S-5 S-4 and CB-2 are all mixtures of the upstream Qnt aquifer water represented by the Qnt sample and groundwater flow coming from the Generating Station area represented by the Qal-1, 2 and 3 samples, because the Well D, CB-1, S-5, S-4 and CB-2 samples all plot on a straight line between Qnt-1 and Qal-1, 2 and 3. The variations in TDS along the groundwater flow path can be explained by concentration by evapotranspiration and dilution by the tributary flow along the flow path.

In summary, the data presented provides us with reasonable confidence that the water sampled at S-4 and S-5 contains a component of groundwater coming from the Generating Station area.

The sources of the arroyo water sampled at station S-8 are difficult to explain due to a general lack of groundwater data in the area. The arroyo water sampled at station S-11 almost certainly consists of Qnt groundwater with direct contributions of Farmers Mutual Ditch irrigation water and irrigation water, which percolates downward from the irrigated fields of the Dunlap Farm (FIGURE 1) and enters the Qnt aquifer.

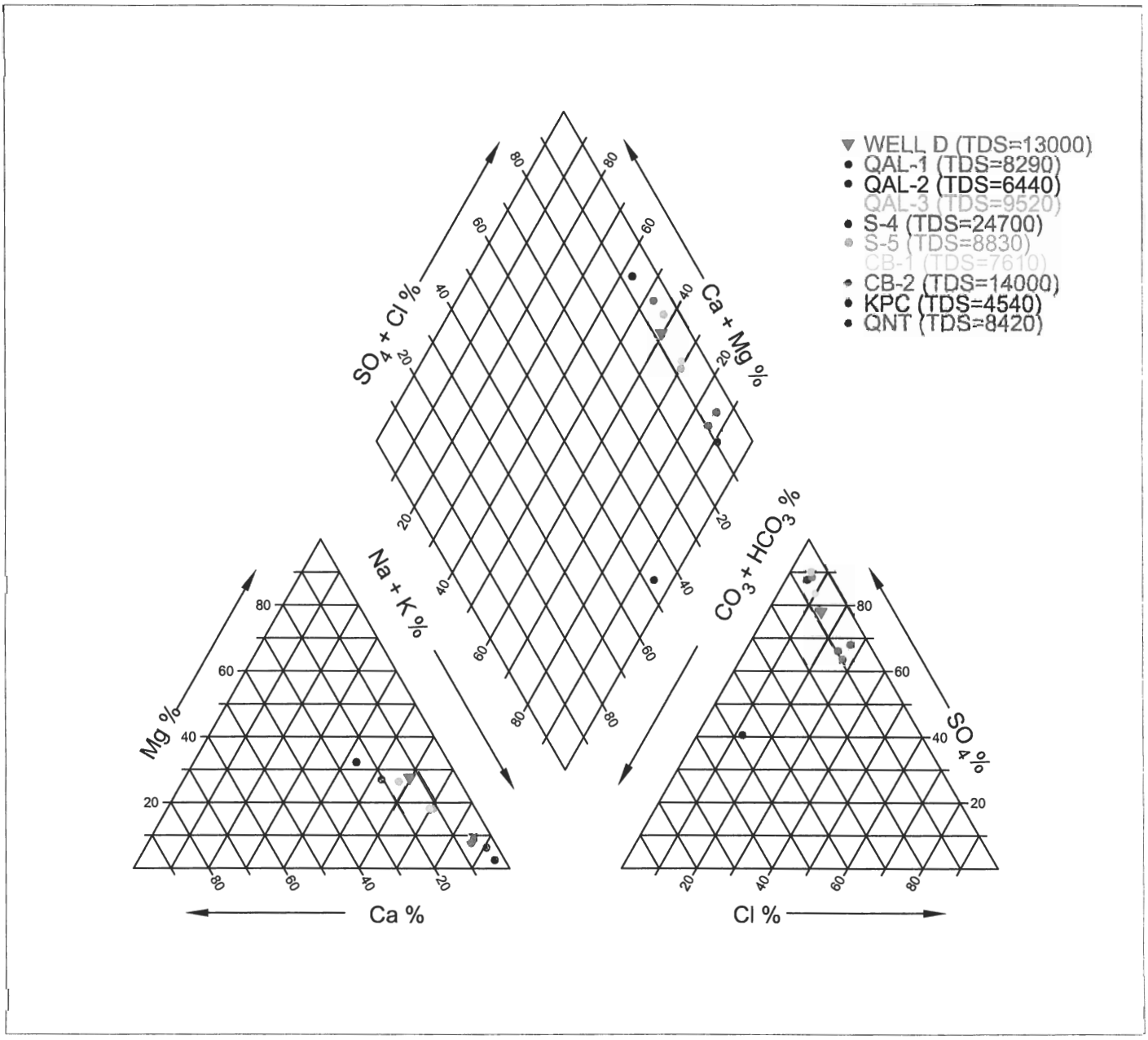

FIGURE 2
TRILINEAR DIAGRAM

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